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THE IONIZATION OF GASES AS A TYPE OF CHEMICAL ACTIVATION[1]

"Chemical activation" is a generic term embracing the various processes by which substances are brought into a state of chemical activity. The use of this term is by no means new, but the intense investigation of the subject during the past ten years may be regarded as a recognition of the incompleteness of our knowledge of one of the fundamentals of chemistry.

We are by now fully aware of what earlier was not so apparent that the commonest and most useful type of activation, that of temperature influence, is the most complex of all in point of theory. The numerous attempts to relate temperature coefficient of velocity of reaction through the internal radiation theory, or to explain it in other ways have at best left the subject in an unsatisfactory condition. However, it is not my purpose to discuss these attempts but to take up one of the simpler types of activation.

Of the non-thermal modes of activation, besides contact catalysis we have the various radiant forms, including photochemical rays and the different kinds of corpuscular streams which may be made to act on gaseous systems. The primary activated products of these various radiative agencies may be classified as free atoms, excited atoms or molecules, and ionized atoms or molecules. In ionization an electron is entirely removed from an atom or molecule, thus producing negative and positive charges which are capable of quantitative measurement by electrical discharge methods. Uncharged atoms do not have any properties by which their concentrations can be so definitely determined. For this reason, if we apply a source of energy so as to produce a known quantity of ions in a given system, in which the chemical reaction produced can also be measured, we are in a position to establish more accurate and definite relations between primary activation and resulting chemical action than has been done in any other type of activation.

In electrolysis, the ratio of discharge of ions at the electrode to chemical action produced is expressed in Faraday's law. In an ionized gaseous system where no field is imposed and hence no current flow-

[1] Address at the presentation of the W. H. Nichols Medal by the New York Section of the American Chemical Society, March 5, 1926.

ing, the ions are discharged, not at an electrode, but throughout the bosom of the gas by a process of recombination of the positive and negative ions. This process is not extremely rapid because of the low momentary concentration of the ions. A given ion, positive or negative, exists long enough to make a large number of kinetic collisions with the electrically neutral molecules. Owing to the electrostatic field about the ions they exert an attraction toward molecules which they encounter and thus are not only chemically active themselves but also become activating centers by drawing neutral molecules into ionic clusters. When a positive ion cluster thus formed encounters a negative ion cluster or a free electron, electrical neutrality is reestablished. The neutral cluster is then subject to the forces of ordinary chemical valency, and may become stabilized as such, or may break down into simpler compounds or elements, or may even polymerize to form higher molecular compounds. We find these various types of behavior represented by different chemical systems or even occurring simultaneously in the same system. The important point is that gaseous ions are chemically active and cause reactions to take place equally well at ordinary or low temperature as at the higher temperatures usually required. Thus we eliminate the complicating influence of temperature. In the second place, the ion acts only once, the clusters are not catalyzing centers capable of causing, by a process of repetition, a large amount of reaction without being themselves changed, as in contact catalysis. The ion clusters formed are stable only as long as they are charged, and on neutralization then take their final chemical states and become again inert without setting up a reaction chain. Thus the number of molecules entering into reaction per one ion-pair is a small and definite one. If the number of molecules reacting in unit time is M and the number of ion pairs formed in the same time is N, the ratio M/N expresses the relation of the chemical activity of the ions, and has been found to vary for different reactions between narrow limits, about 0.5 up to about 20, with a marked peak in the region of 2 to 6.

Since the gaseous ions, unlike electrolytic ones, continually destroy themselves by recombination, it is necessary in studying their chemical effects to have a source of energy that will continue to generate them in known quantity. Electrical discharge is the most ready source of gaseous ions, but has for our purpose the fatal disadvantage that the ionization produced by it can neither be measured nor accurately estimated. Quite a different source has been found suitable; namely, the ionization produced by alpha particles from radioactive material, the most convenient form of which has proved to be radon (radium emanation) in equilibrium with its decay products.

Radon has the advantage of very small gaseous volume for very large radiation; hence it can be distributed evenly in any system and does not appreciably absorb its own alpha rays. It may be employed in two ways: (1) by mixing it directly with the gases to be acted on; (2) by confining it over mercury in a small thin glass bulb of 1 to 2 mm diameter and a few thousandths of a mm thick, which transmits the alpha particle with but a small loss of its energy.

By examining such an alpha ray bulb containing radon, one perceives in its immediate vicinity a distinct odor of ozone, due to the action of the alpha rays on the oxygen molecules of the air.

An alpha ray is the doubly charged nucleus of a helium atom ejected from the nucleus of a radioactive atom with a velocity of one fifteenth to one twentieth that of sunlight, or nine to twelve thousand miles per second. When a particle of atomic dimensions is moved with so high a velocity, a tremendous amount of kinetic energy is available. The particles travel in all directions in straight lines through a large number of gaseous molecules, expending their energy by tearing off electrons, each particle producing in its path about two hundred thousand ion-pairs in the form of singly charged and probably molecular ions. The negative electrons thus liberated later recombine with the positive ions, to reestablish electrical neutrality as has already been described. If the gaseous medium be a mixture of gases, each one will be ionized in proportion to its partial pressure and its own specific ionization. The ion clusters then formed will contain more than one molecular species which may be thus brought into chemical interaction.

If a gas is present with affinity for free electrons, union will result in the formation cf negative ions. Both positive and negative ions have the property of clustering neutral molecules about them. We do not know definitely the size of these clusters, but we shall have occasion to examine the chemical evidence for certain minimum values.

Returning to the case of ozone, if we mount one of the thin bulbs at the center of a sphere six cms in diameter and surround it with pure oxygen, we can fully utilize the ozoning power of the alpha rays, which will then spend themselves in oxygen in all directions. If the inoized oxygen is passed through a KI absorbing system we can measure chemically the number of ozone molecules formed (M_{O_3}). If the quantity of radon in the small bulb is measured by comparison with the gamma radiation from a known quantity of radium, we will know the number of alpha particles being emitted. Thirty-seven billion

are emitted per second from one curie of radon and an equal number from each of the decay products, RaA and RaC. Then by making allowance for the small loss of path in the thin glass wall, the length of path in oxygen and consequently the number of ion-pairs formed in oxygen can be calculated from a knowledge of the ionization per length of path. Such an experiment[2] gave a value of $\frac{M_{O_3}}{N_{O_2}}$ in the neighborhood of unity. This surprising agreement of ionization and ozonization not only strongly suggested an ionic mechanism of ozone formation but raised the question whether a similar relation might not apply in other gas reactions.

Previous to the ozone experiments, Sir William Ramsay and A. T. Cameron[3] in London had made a systematic examination of a number of gas reactions employing radon directly mixed with the reactant gases. They used the manometric method of determining the rate of reaction. In order to magnify the pressure change they employed rather small reaction vessels of only a few cc in volume, in which the alpha particles do not complete their paths in the gas but expend most of their energy in the glass wall of the container, where it contributes nothing to the chemical action. This principle is still found very useful, in spite of its inefficiency of utilization of the alpha rays.

The law which Cameron and Ramsay formulated did not deal with ions nor even with alpha particles. They contented themselves in establishing the relation that the rate of reaction in a given volume is proportional to the quantity of radon (E) present at any time t, which rate may be expressed in terms of pressure change by the simple formula:

$$\frac{dP}{dt} = cE_t,$$

where c is a velocity constant. When it is recognized that it is the alpha particles emitted, not the radon atoms themselves which cause reaction, we realize at once that while the law of Cameron and Ramsay is valid for liquid systems, where the concentration of the reactant remains unchanged as in the decomposition of water by radon, the case is different in a *gas* where the pressure is changing. As the gaseous pressure of the reactants is diminished by the progress of the reaction, the alpha particles encounter fewer molecules along their paths, hence the rate of reaction is proportional also to the changing pressure P_t. This gives a more complete form of law:

$$\frac{dP}{dt} = cE_t \cdot P_t \qquad (1)$$

[2] Lind, *Amer. Chem. Jour.*, *47*, 397–415 (1912); *Monatsch. f. Chem.*, 32, 295–310 (1912).

[3] Cameron and Ramsay, *J. Chem. Soc.*, *93*, 966–92 (1908).

The rate of the production of ions is also proportional to the same two factors:

$$\frac{dN}{dt} = kE_t \cdot P_t \qquad (2)$$

$$\text{or } \frac{dN}{dt} = 3 \times 3.7 \times 10^{10} \,.\, E_t \,.\, 2.5 \times 10^4 \text{ p.i.P}/760 \qquad (2a)$$

The identity of the two expressions (1) and (2), except for the proportionality factors, would indicate a causal dependence of chemical action on ionization, the same conclusion as was first reached from the ozone work.

$$\text{Therefore, } \frac{dP}{dt} = \mu \frac{dN}{dt} \qquad (3)$$

and since $E_t = E_0 e^{-\lambda t}$, by combining (2) and (3) and integrating, we have a general velocity equation:

$$\frac{k\mu}{\lambda} = \frac{\log \frac{P}{P_0}}{E_0(e^{-\lambda t} - 1)} \qquad (4)$$

Or in calculating from one interval to the next:

$$\left(\frac{k\mu}{\lambda}\right)' = \frac{\log \frac{P_1}{P_2}}{E_0(e^{-\lambda t_1} - e^{-\lambda t_2})} \qquad (5)$$

in which λ is the decay constant of radon. In simplest terms, $\frac{k\mu}{\lambda}$ is a velocity constant, composed of three other constants; k embodies all the constant factors of (2a) with reference to ionization; μ and λ have been defined. In actual numerical value $\frac{k\mu}{\lambda}$ is the *number of times that a given volume of gas would be "cleaned up" by the decay of 1 curie of emanation, while the pressure is held constant in that volume by feeding in fresh gas continuously.* The equation is applicable to vessels of any shape or size in which no dimension exceeds the range of the shortest alpha particles, but the constant k will change with the shape and volume of the container; therefore, for convenience in calculating the average path of alpha rays, we have used spherical vessels only. Both k and μ are also dependent on the nature of the gas or gaseous mixture. The function of volume is to increase the effective paths linearly with the diameter, but since the pressure effect will diminish with the volume, *i.e.*, with the cube of the diameter, velocity constants expressed in terms of pressure change will diminish in value with the inverse square of the diameter.[4]

The apparatus used in my earlier work[5] had two or three disadvantages. The large mercury surface exposed in some cases caused a secondary reaction of mercury with one of the components. The apparatus could not be conveniently placed in a thermostat.

[4] Lind and Bardwell, *J. Am. Chem. Soc.*, 46, 2005 (1924).

[5] *J. Amer. Chem. Soc.*, *41*, 535 (1919).

In that connection it should be mentioned that ionization by alpha rays is independent of temperature; correspondingly we find most of the ionic-chemical reaction rates independent of temperature, but occasionally some influence of a secondary character is observed, so that all of our recent work is done at 25° C. In the later type[6] the earlier disadvantages are corrected and in addition a vacuum manometer is provided for the lower ranges of pressure measurement.

It would be impossible to consider in detail all the forty or fifty reactions that have been studied. The kinetics of water synthesis may be considered as a typical case, prior to reviewing briefly the principal features of some of the other reactions we have studied.

The data for water synthesis (Table I) show that the velocity equation (5) applies over a wide range of pressure. Since the constant $\frac{k\mu}{\lambda}$ is calculated from interval to interval, the test is a severe one. A distinct rise in constants is observable toward the end of the reaction. This is due to the relative predominance of the chemical effect of the recoil atoms at low pressures. Correction for this effect has been made in the M/N column where a more satisfactory constant results.

TABLE I

SYNTHESIS OF WATER BY α-RAYS OF RADON

$$2H_2 + O_2 = (2H_2O)$$

Temp. 25° C.

Reaction Sphere $\begin{cases} \text{Vol.} = 3.772 \text{ cc.} \\ \text{Diam.} = 1.932 \text{ cm.} \end{cases}$ $E_0 = 0.1062$ curie

Time, Days	Time, Hours	$P(2H_2+O_2)$ mm.	$\frac{k\mu}{\lambda}$	$\frac{+M(H_2O)}{N(H_2+O_2)}$
0	0	1115.1	....	....
0	4	1039.1	22.4	3.48
0	22.13	740.1	25.9	3.93
1	2.0	687.9	28.4	4.27
1	23.13	505.3	24.10	3.60
2	22.63	365.6	26.8	3.94
3	22.88	278.5	26.1	3.74
5	0.08	217.7	27.5	3.74
6	23.75	143.1	32.7	4.10
8	23.17	101.1	38.02	4.26
				Weighted Ave. = 3.85

The condition that the specific ionization of the mixture remain constant is satisfied by electrolytic gas $(2H_2 + O_2)$, because water is continually removed from the system by condensation, and the proportion of H_2 to O_2 remains 2:1. If we start, however, with excess of either component,[7] this is no longer true, and the departure is greater the farther the reaction progresses. If we start with excess of H_2 the constants are lower and fall as the reaction proceeds because the proportion of hydrogen is increasing, and since hydrogen has a specific ionization of only about 1/5 that of oxygen, the ionization of the mixture per unit path of alpha particle diminishes rapidly with increasing proportion of hydrogen. If we begin with excess of oxygen the opposite is true; the constants start high and tend to rise.

The last column of Table I shows the number of water molecules synthesized per ion-pair produced in the mixture, $\frac{+M(H_2O)}{N(H_2+O_2)}$. This value, unlike the velocity constant, has been found to be independent of the variation of the ratio H_2/O_2, which demonstrates a very important principle: the ions of either component are equally efficient in producing chemical action and the reaction mechanism and ionic efficiency are independent of the reaction mixture. As a corollary from this it is evident that only one component need be activated, though both are activated by α-radiation. This principle has been demonstrated for a number of other reactions.

From the M/N ratio we may at least speculate about reaction mechanism. Around a positive ion, either O_2^+ or H_2^+, a stoichiometric cluster is formed $(H_2.O_2.H_2)^+$. Perhaps the cluster while charged is much larger, but the stoichiometric portion alone reacts chemically; if other H_2 and O_2 molecules are attached to the charged ion, they slough off unchanged when it is neutralized. A similar cluster $(H_2.O_2^-.H_2)$ is formed about a negative O_2^- ion. Since H_2 has no affinity for free electrons no H_2^- ions are formed, but all the electrons formed by ionization of hydrogen will be seized by the O_2 molecules, so that full utilization of both positive and negative ions results. Finally the positive and negative clusters recombine in the ordinary way: $(H_2.O_2.H_2)^+ + (H_2.O^-.H_2) = 4H_2O$, in agreement with experiment. Slight deficiency below 4 may be accounted for by cross reactions before the clusters are complete, such as $(H_2.O_2.H_2)^+ + (-) = 2H_2O$; or $(H_2O_2)^+ + (-) = H_2O_2$, etc. The actual formation of H_2O_2 by alpha rays up to considerable percentages was observed by Scheuer.[8] Taylor[9] has recently produced H_2O_2 quantitatively in 100 per cent. purity by the action of mercury vapor activated by resonance of the 2537 Hg line on an H_2–O_2 mixture.

[6] *Ibid.*, *47*, 2679 (1925).

[7] *J. Am. Chem. Soc.*, *41*, 542 (1919); "Chemical Effects of Alpha Particles," New York, 1921, pp. 107–110.

[8] O. Scheuer, Comp. rend., 159, 423 (1914).

[9] H. S. Taylor, unpublished results by private communication.

The conclusions as to the ionic mechanism of water synthesis have not been drawn from that reaction alone but also by analogy from a large number of other reactions. We may consider briefly, two of them, closely related to water synthesis—the oxidation of carbon monoxide and of methane. If we radiate pure carbon monoxide with alpha rays, two molecules of CO decompose per ion pair and neglecting the formation of sub-oxide we formulate the main reaction: $CO^+ + CO = (CO)_2^+$ followed by $(CO_2^+ + (-) = CO_2 + (C)$. In the presence of oxygen, however, no free carbon is found, and four instead of two CO molecules and in addition two O_2 molecules all unite to form four molecules of CO_2 per one ion pair (just as in water synthesis) which we formulate similarly $(CO.O_2.CO)^+ + (CO.O_2^-.CO) = 4CO_2$ and also for methane oxidation $(O_2.CH_4.O_2)^+ + (O_2.CH_4.O_2)^- = 2CO_2 + 4H_2O$.

From the reactions of oxidation we deduce the principle of the *exclusivity of oxidation.* For example, when alone, CO decomposes to form carbon dioxide, sub-oxide and free carbon, but in the presence of oxygen it is oxidized exclusively to CO_2. Methane alone condenses to form higher hydrocarbons with the elimination of free hydrogen as: $CH_4^+ + CH_4 + (-) \rightarrow C_2H_6 + H_2$ (also $C_2H_4 + 2H_2$), but in the presence of oxygen, methane is completely oxidized to H_2O and CO_2. One might think this is simply the result of secondary reaction by which C, H_2 or C_2H_6 could not remain in the system in the presence of oxygen. The kinetics for this reaction leads to the conclusion, however, that the reaction is the direct one formulated, not a series of successive reactions. Moreover, in the case of carbon monoxide twice as many molecules of CO react in the presence of oxygen as in its absence, owing to the effectiveness of the O_2^- in clustering, whereas, when only CO is present there are no negative ions because CO has no affinity for free electrons, which come back "empty handed," so to speak, in completing the reaction by reestablishing electrical neutrality. In other words, in the presence of oxygen, the negative charge which recombines to fix the reaction will always bring with it O_2, thus making oxidation exclusive, because the positive cluster can find no electrons unaccompanied by oxygen.

The exclusivity of oxidation has held without exception in all the reactions examined. Cyanogen when alone polymerizes to a black solid, probably paracyanogen; with oxygen it forms only oxidation products, including a light yellow addition product $(CNO)_x$. Acetylene alone forms the yellow powdery polymer cuprene; with oxygen it gives a colorless liquid and other oxidation products, but no cuprene. Ethane, propane and butane in the absence of oxygen give liquid and solid condensation products with elimination of free hydrogen, but with oxygen they are either oxidized directly to CO_2 and H_2O as are CH_4 and C_2H_6 or to partially oxidized products as C_3H_8 and C_4H_{10} are. Also in agreement with this

TABLE II

CHEMICAL EFFECTS OF α-RAYS. VARIOUS TYPES OF REACTIONS

Reaction	Assumed Clusters		Theory	Found
$2(2H_2 + O_2) \rightarrow$	$(H_2.O_2.H_2)^+$	$+ (H_2.\bar{O}_2.H_2)$	$= 4H_2O$	$3.85 H_2O$
$2(2CO + O_2) \rightarrow$	$(CO.O_2.CO)^+$	$+ (CO.\bar{O}_2.CO)$	$= 4CO_2$	$4.1 CO_2$
$2(CH_4 + 2O_2) \rightarrow$	$(O_2.CH_4O_2)^+$	$+ (\bar{O}_2.CH_4.O_2)$	$= 2CO_2 + 4H_2O$	$1.6 CO_2 + 3.2 H_2O$
$2(C_2H_6 + 3\frac{1}{2}O_2) \rightarrow$	$(CO_2.O_2.C_2H_6O_2.O_2)^+$	$+ (O_2.C_2H_6.\bar{O}_2.O_2)$	$= 4CO_2 + 6H_2O$	$3.3 CO_2 + 5.0 H_2O$
$2CO \rightarrow$	$(CO)_2^+ + (-) \rightarrow$		$CO_2 + (C) + (C_3O_2)$	$-2 CO$
$2CH_4 \rightarrow$	$(CH_4)_2^+ + (-) \rightarrow$		$C_2H_6 + H_2$ $C_2H_4 + 2H_2$	$-2.2 CH_4$
$2C_2H_6 \rightarrow$	$(C_2H_6)_2^+ \; (-) \rightarrow$		$C_4H_{10} + H_2$ $C_4H_8 + 2H_2$	$-1.7 C_2H_6$
$2C_3H_8 \rightarrow$	$(C_3H_8)_2^+ + (-) \rightarrow$		$C_6H_{14} + H_2$ $C_6H_{12} + 2H_2$	$-1.7 C_3H_6$
$2C_4H_{10} \rightarrow$	$(C_4H_{10})_2^+ + (-) \rightarrow$		$C_8H_{18} + H_2$ $C_8H_{16} + 2H_2$	$-1.8 C_4H_{10}$
$xC_2H_4 \rightarrow$	$(C_2H_4)_x^+ + (-) =$		$(C_2H_4)_x$	$x = 5.1$
$xC_2N_2 \rightarrow$	$(C_2N_2)_x^+ + (-) =$		$(C_2N_2)_x$	$x = 7.4$
$xHCN \rightarrow$	$(HCN)_x^+ + (-) =$		$(HCN)_x$	$x = 11.1$
$xC_2H_2 \rightarrow$	$(C_2H_2)_x^+ + (-) =$		$(C_2H_2)_x$	$x = 19.8$

general theory is the fact that hydrogenation of unsaturated compounds is not exclusive; polymerization takes place simultaneously, because H_2 can not form H_2- ions by trapping low velocity electrons, therefore, the positive polymeric clusters can be neutralized by free electrons.

The following list (Table II) of reactions will illustrate these and other points. In the group of oxidation reactions, it will be observed that the stoichiometric principle for both positive and negative ions is quite well confirmed by the M/N values found.

In the group of five decompositions, where no gas is present with electron affinity, it will be observed that the positive cluster is limited to the value of *2*, one neutral molecule and one positive ion entering into reaction. Perhaps this rule may be generalized for the clustering of saturated molecules with themselves.

On passing, however, to unsaturated compounds of carbon, the clusters are larger. Ethylene shows a value above 5, and the triple bond compounds cyanogen, acetylene and hydrogen cyanide show values yet higher, from 8 up to about 20.

As already stated, we do not know the actual size of these clusters, nor has the physical evidence from migration of ions proved unambiguous, even in the simplest cases. If the theories here advanced are correct, we may say that the chemical evidence definitely sets lower limits. Perhaps the clusters are in reality larger. If in general they all initially contain about the same large number of molecules, then evidently the clusters of unsaturated compounds have the greater stability after neutralization. This stability of the clusters of triple bond compounds is further illustrated by the fact that when acetylene polymerizes only 2 per cent. of its H_2 is liberated, cyanogen liberates 5 per cent. of its N_2, HCN 2.5 per cent. of its H_2 and 8 per cent. of its N_2, while ethylene splits out 19.5 per cent. of its H_2, giving a mixture of hydrogen and methane containing 91 per cent. H_2 and 9 per cent. CH_4 by volume, while methane splits out 37.5 per cent. of its H_2 in the free state, during complete reaction.

The studies which I have attempted to describe briefly should be regarded as exploratory. While they set up a general preliminary theory and have put the kinetics in quite a satisfactory state, they have hardly more than scratched the surface of the possible ionic gas reactions, which may prove to have significance in the preparation of new and unusual compounds. Since the reactions take place at low temperatures, they will give many addition-products which would be decomposed at higher temperatures. A number of such compounds not described in the literature have already been observed, but have not yet been prepared in sufficient quantity for thorough examination. The preparative phase of this subject is an attractive field for future investigation, where perhaps more abundant sources of ionization may profitably be employed, since quantitative knowledge of the ionization itself would not be necessary for preparation alone.

S. C. LIND

FIXED NITROGEN RESEARCH LAB.,
WASHINGTON, D. C.,
MARCH, 1926

SIGMA XI IN RESEARCH[1]

SIGMA XI has gained the confidence of all who know its ideals. To-night's initiates are to be congratulated, for the Iowa chapter has had an honorable history. Since it was organized twenty-six years ago, the policy of this chapter has always been conservative, and at the end of the tenth year we find only 161 members, of whom fifty-one were active members. For the year 1911 to 1912, I find the president was Raymond; vice-president, Seashore; recording secretary Pearce; corresponding secretary, Hauser; treasurer, Wylie; and counsellor, Macbride. It was about this time that Iowa began to lay the foundation for the present rapid growth in research.

Sigma Xi stands not only for cooperative research, but also promotes scholarship through selecting the unusual men and women who have that promise of power in research which enables them to go beyond the set limits of knowledge. I fear that sometimes we fail to recognize different types of research workers. Some scientists prefer to discover new material; some to work over the material discovered by others with a view to testing, verifying, or elaborating the principles set forth; some to interpret and to coordinate and correlate the data discovered by others; some prefer to criticize and if possible destroy the principles or theories formulated by others; others, like the professor in the small college, to inspire or train younger students who later catch the spirit of research and carry their training into larger institutions with marked success. All these types are needed; all have their places in furthering the bounds of human knowledge, providing they are in their final endeavors creative.

My own interest in science was comparatively late in maturing. Having lived on a farm in my childhood and youth, I assembled numerous natural history collections, but it was not until I went to college that I became fascinated, under the direction of Dr. Spencer Trotter, with scientific inquiries. While a

[1] President's address at the annual initiation of the Iowa chapter of the Society of the Sigma Xi, State University of Iowa, Iowa City, Iowa, February 17, 1926.

sophomore at Swarthmore, I had access to the extensive collection, first hand drawings and the original paintings of Joseph Leidy. These opened up an entirely new world to me, for Leidy was no doubt the greatest paleontologist of his century. Moreover, he lived at the most opportune period of the whole range of natural history. The western hemisphere offered new opportunities for him. His work was predominantly original, for practically every specimen he found was a new species, a new genus, a new family or a new order. None was named or described in the predominating French literature. Leidy was the last great scientific naturalist in history. It has been said that he studied protozoa and man with the same avidity and the same thoroughness.

Traditions at Swarthmore placed Leidy as a great, unpretentious, thoughtful man who had to be piloted to his laboratories and museums on the fifth floor of the main college building or he would lose his moorings and go wandering around the halls of the building. Leidy was an ideal research man of the cooperative, observing type. Speaking of him two years ago, Henry Fairfield Osborn, of the American Museum of Natural History, said: "Even to this day we are verifying the observations of Leidy. We find that he never made an incorrect observation, or published an incorrect figure. His accuracy is these records is one of his greatest and most permanent claims to immortality as a paleontologist." It has been said that two of Leidy's contemporaries were so busy quarreling with each other that neither ever mentioned Leidy in their books, although each described and named species previously named and described by Leidy.

As a junior in college, I began to trace Indian trails around Philadelphia, and the subject of the thesis for my degree of bachelor of science was a detailed description of an Indian skeleton excavated from the banks of the Brandywine. This skeleton, found six feet under ground in a stone coffin with pieces of wampum, four hundred beads and some crude jewelry, made my heart beat with enthusiasm. It was the first experience of the real joy of discovery. I had caught some of the spirit of Agassiz when he said to William James and his other assistants, when starting on his famous trip to South America:

Come wander with me—
In regions yet untrod,
And read what is still unread
In the manuscript of God.

It was not until I was on my way to Harvard that I shifted my interest from paleontology and animal behavior to human behavior. Here I obtained an opportunity to study with James, Royce and Yerkes, but for the first two years I acted as special tutor in G. H. Parker's course in zoology.

If I were to offer suggestions from my own experience to our new members, I would say:

(1) Select a basic problem for your research, one that you can work on for a period of ten years or more. For example, one of my graduate students has just completed special experiments in the learning of preschool children and one in the emotional development of preschool children. These are special fields in which the students can continue their investigations for at least a ten year period.

(2) Become thoroughly acquainted with the history of your problem and especially with contemporary experimental studies in your special field. Become well orientated and familiar with the principal theories and conclusions of others who have approached your problem. Frequently you can find the best cues for your attack in earlier studies. For example, I became thoroughly convinced of the value of the study of consecutive physical growth curves after having found Quetelet's early investigations, of 1836.

(3) Strive for a complete bibliography of your special subject; do not be satisfied with a few general references. References are of little or no value unless they are complete.

(4) Take accurate, detailed notes each day and keep them in an accessible file. This will furnish the material for your final report, for it is very difficult to write a final report with statistical data only. Keep a notebook or pad in which you can jot down your original ideas and theories from time to time. These original ideas are frequently the most important contribution.

(5) Do not spare any effort in securing accurate data. One of the greatest enemies of first class scientists is the use of inaccurate data.

(6) Study carefully your experimental technic and present your data in the best statistical form. Be certain that your tables are self-explanatory and presented in such a way that the number of observations are apparent. See that the charts and curves are also self-explanatory and constructed according to the best modern standards.

(7) Lastly, I would say, look for the relationship of your problem to the larger field of which it is a part. Many scientists are unable to see the woods for the trees. Reorientate the problem. In doing so you will acquire the true research spirit, not the kind that terminates with the degree of doctor of philosophy.

To those who leave the university this year I wish to say:

(1) Act as scientific centers for your respective communities and institutions.

(2) Help to introduce more and better science into our public schools. My personal opinion is that science offers the best moral training that the curriculum has to offer, since its basic principles are accuracy,

honesty, cooperation and respect for the achievements and rights of others.

(3) Help to disseminate scientific information, for practice has lagged far behind theory in many fields.

(4) Never let a year go by without carrying out a definite piece of research, adapted to your qualifications, your opportunities and your facilities. See that it is worth publishing, but be sure that it is ready to print before you submit it, for you can never do this particular piece of work again.

(5) Keep in close touch with your major professors. You will always be a part of this university. Your field laboratories are but extensions of our own central laboratories. You can help us and the university quite as much as we can help you.

To those who remain with us I wish to say:

We must lead the life of research, not talk about why we are unable to live it. In our field there is no substitute for ardent, sincere daily effort and consecutive application. It is the ability to work a little longer, a little more in detail, a little more accurately than any one else, under the guidance of our own constructive imagination and thought, that will place us as authorities in our own special fields.

Just as the musician finds pleasure in melody and rhythm and the artist satisfaction in symmetry and proportion, we find the most exquisite delight in discovering new data, verifying tentative principles or formulating new hypotheses. There is perfect abandon in the joy of accomplishment, for the discovery of truth is reality. The search for truth, the living of the truth, the dissemination of the truth are our highest motives. Let us zealously guard and protect our opportunities for research.

We are fortunate to have as president of this university a man with a great vision, who, with the dean of the graduate college and the deans of the colleges of liberal arts, law, medicine, dentistry, pharmacy, applied science, education and commerce, has advanced research on all sides in this university. When I came here eight years ago, I was the first appointee with the title of research professor. To-day scores of professors and instructors are spending half or two thirds of their time in research work, and others are devoting their time exclusively to research. In the preparation last year of a bulletin from the Station on what the University of Iowa is doing for children, twenty departments and colleges in the university were found to be carrying on some phases of research dealing with children. This is probably not possible at any other university in this country at the present time. In this university more than half a million dollars is going annually into research and service for children.

We are steadily gaining a position of preeminence as a research university, especially among the state universities. Research is a source from which real service functions; our opportunities are unusually good. From us much will be expected. Our university has broken down many departmental barriers that still exist in some of the older institutions of higher learning. On all sides we see cooperation. Let us be truly "companions in zealous research."

BIRD T. BALDWIN

IOWA CHILD WELFARE RESEARCH STATION,
STATE UNIVERSITY OF IOWA

EZRA TOWNSEND CRESSON

IN the death of Ezra Townsend Cresson, at Swarthmore, Pennsylvania, on April 19, 1926, there passed away one of the most kindly, helpful and amiable figures in American entomology. In February, 1859, when not yet twenty-one, he, with James Ridings and George Newman, founded the oldest of our existing entomological societies—The Entomological Society of Philadelphia, whose name was changed in 1867 to The American Entomological Society. A group of enthusiastic collectors and students gathered, whose activities are described by Baron Osten Sacken, entomologist and secretary of the Russian legation at Washington:

> Residing, as I did, in Washington (up to 1862), I had the opportunity of witnessing the origin and first beginnings of the Society. To me, a European, these beginnings afforded such a remarkable insight into American energy and enterprise that I am glad to give a short account of them. . . . The most active member of the Society, however, was its Corresponding Secretary, Mr. Ezra T. Cresson, with whom I kept up at that time an active correspondence. I shall content myself with reproducing passages of his letters, which speak for themselves.
>
> On September 4, 1861, Mr. Cresson wrote: "We do our own printing, as you already know; I am the compositor and also assist in the press work, and although I have had little or no experience in setting type (I have set the type for *all* the pages of the *Proceedings* thus far), yet be assured that I will do my best to have your paper got up in as neat and scientific a style as possible."[1]

Cresson devoted himself to the Hymenoptera of North America, not neglecting those of Cuba and of Mexico, and produced, between 1861 and 1882, some sixty-five catalogues, synopses and monographs, culminating in a "Synopsis of the Families and Genera of the Hymenoptera of America north of Mexico" (together with a catalogue of the described species,

[1] "Record of My Life Work in Entomology," Cambridge, Mass., 1903, pp. 41–42. Osten Sacken's date, 1861, as that of the foundation of the society is, however, two years too late.

and bibliography), a volume of 350 pages, published by the American Entomological Society in 1887. For thirty years, or until the appearance in 1916 of "The Hymenoptera of Connecticut," by H. L. Viereck and collaborators, under the editorship of Dr. W. E. Britton, Cresson's "Synopsis" was the only general guide to the study of North American Hymenoptera in existence. It was supplemented by his paper of 1916, "The Cresson Types of Hymenoptera" (Volume I, number 1 of the "Memoirs" of the same society), in which he gives what is practically a full index to all his previous writings on these insects.

A man of the greatest diffidence, devoid of all self-display, shrinking from notoriety of all kinds, editing the *Transactions* of his beloved society for forty-two years (1871–1912), serving as its treasurer for fifty years (1874–1924), he is, in the memories of his associates, the personification of unselfishness and of devotion to the advancement of science.

A detailed account of his scientific work is in preparation for publication in the *Transactions of the American Entomological Society*. Any one having letters from him which would add to the value and interest thereof is requested to lend them to the undersigned for copy or extract. Such will be returned promptly.

Philip P. Calvert

Zoological Laboratory,
University of Pennsylvania

SCIENTIFIC EVENTS

THE SCIENTIFIC JUBILEE OF CHARLES RICHET

On May 22, 1926, there was celebrated in the meeting hall of the Paris Academy of Medicine the scientific jubilee of Professor Charles Richet, the great French physiologist, to fittingly mark his fifty years of teaching. The ceremony was presided over by the distinguished mathematician, Professor Paul Painlevé, of the Sorbonne, now minister of war for France. Next to him were Marshal Foch and Professors Bar, president of the Paris Academy of Medicine; Roger, dean of the Paris Medical School; Henneguy, president of the Société de Biologie, and Gley, of the Collège de France. A large and highly enthusiastic audience, in which were many of the best-known scientists of France and other countries of Europe, crowded the large hall.

Professor Henneguy, in the name of the Société de Biologie, which organized this jubilee, brought the collective homage of his colleagues to one of the most eminent representatives of the biological sciences and briefly enumerated his most important discoveries—serotherapy and anaphylaxis—which give him a place next to Pasteur and Claude Bernard.

Dean Roger, of the Paris Medical School, spoke of Richet as the scientist, as the philosopher, author of "L'homme et l'intelligence," as the poet and as the dramatist, author of "La magicienne Circé," which was played by Sarah Bernhardt. He spoke of his great influence as a teacher, an inspirer of many young medical men and physiologists, a beacon in the educational world. He showed him in the serene simplicity of his character, which the greatest honors, like the Nobel prize, have not altered in the least, and, finally, as the dreamer in metaphysics and the creator of his metapsychosis. "I have followed you in the chair of physiology," he said, "but you are among those whom one follows but does not replace."

After an address by President Bar, of the Paris Academy of Medicine, Professor Gley, physiologist of the Collège de France, enumerated the most famous researches of the master: on gastric juice, the form of muscular contraction, respiratory combustion, serotherapy, lactic fermentation, zomotherapy and finally anaphylaxis. He finished by saying: "If, as Taine states, the life of a worker consists in sowing, you have very largely sown, Sir."

Eighteen foreign and French physiologists then each said a few words of praise. Léon Fréderieq, in the name of Belgium, decorated Richet with the cross of Grand-Officer of the Order of Leopold. Belgium was also represented by Zunz, Esthonia by Poussep, Yugoslavia by Jiaga, Portugal by Rebello, Rumania by Cantacuzène and Athanasiu, Russia by Metalnikoff, Armenia by Torkomian, Scandinavia by Söderberg, Italy by Botazzi, Fano and Perroncito, and there were also representatives for Denmark and Czechoslovakia. Richet gave the "accolade" to his French colleagues, Abelous, of Toulouse; Pachon, of Bordeaux; Mouriquand, of Lyon, and Bedart, of Lille.

Marshal Foch pinned on Richet's breast the same plaque of Grand-Officer of the Legion of Honor which had been worn by the latter's grandfather, and Minister Painlevé, in a moving allocution, stated that while Richet had already fought for France in 1870, he earned the Croix de Guerre in 1918 at Château Thierry as a medical volunteer, in spite of his age. He presented Richet with a jubilee volume and a bust by the sculptor Landoski.

Finally Charles Richet, in the midst of an indescribable enthusiasm, thanked those who had spoken and ended by saying: "La science est une grande dominatrice, c'est elle qui crée le progrès. . . . Le savant doit se pencher sur ses microscopes et ses cornues, mais il doit aussi se pencher vers la justice, la patrie, et l'humanité."

Robert F. Le Guyon,
Raoul M. May

Université de Paris

FIELD EXCURSION OF OHIO GEOLOGISTS

THE annual field excursion of the geological section of the Ohio Academy of Science was held on May 28, 29 and 30 in the Sandusky Bay region of northern Ohio. Professor J. Ernest Carman, of the State University, who has been studying the rocks of this region for the Geological Survey of Ohio, was the chief guide for the excursion. The party assembled at Tiffin at noon on the twenty-eighth and traveling by automobile, visited on that and succeeding days rock exposures and quarries in Seneca, Sandusky and Erie counties and on the Marblehead peninsula of Ottawa county. Several industrial plants were visited, including those of the Dolomite Products Company at Maplegrove, the United States Gypsum Company, at Gypsum, and the Castalia Cement Company, at Castalia.

The chief rock division of the region is the Monroe which involves the problem of the systematic boundary between the Silurian and the Devonian systems. As here interpreted, the Lower Monroe or Bass Island formation was assigned to the Silurian system. Of this formation, three members were studied; the Greenfield dolomite, the Tymochtee shaley dolomite and the Put-in-Bay dolomite. The Upper Monroe or Detroit River formation was assigned to the Devonian system. Of this formation the Amherstburg dolomite member and the Lucas dolomite member were studied. Aside from the Monroe the Cedarville (Guelph) dolomite below, and the Columbus and Delaware limestones above were seen. In all eight divisions of the Ohio rock column were seen.

The party numbered from twenty to thirty during various parts of the excursion. The organizations represented include the Geological Survey of Ohio, the Soil Survey of Ohio, the Ohio State University, Western Reserve University, Heidelberg University, Toledo University, Antioch College, Muskingum College, Oberlin College, Kenyon College, the Pure Oil Co., and the East Ohio Gas Co. The excursion was made under the management of Wilber Stout, Geological Survey of Ohio, vice-president for geology of the Ohio Academy of Science.

LEGISLATION AGAINST THE TEACHING OF EVOLUTION IN LOUISIANA

THE lower house of the Louisiana Legislature has passed a bill to prohibit teaching in state supported schools of the theory that man descended from a lower order of animal.

Members of the faculty of the Louisiana State University have presented the following protest to the educational committees of the legislature:

Inasmuch as bills have been proposed before our state legislature with the object of limiting the teaching of certain subjects in our state university; and

Since we believe that such legislation is contrary to the fundamental principles of education by denying impartial presentation of all facts; and

Furthermore, since the charge that the teaching of the theories involved tends to destroy religious beliefs is false; and

Since we believe on the contrary that the study of the vast developmental processes in nature tends to magnify the conception of God by revealing mightier evidences of His power; and

Since we believe that truth and progress can only be gained by unrestricted access to facts; and

Since the forbidding of access to any particular set of facts would stimulate youth to seek these facts for themselves without guidance and hence with far more disastrous possibilities;

Therefore, we, the undersigned, members of the faculty of Louisiana State University, hereby express the firm conviction that the type of proposed legislation mentioned above is a menace to the best interests of all, and should not become a law of this state.

The protest is signed by 143 members of the faculty with six reservations as to the wording.

THE GOLDEN JUBILEE OF THE AMERICAN CHEMICAL SOCIETY

THE seventy-second general meeting of the American Chemical Society will be held in Philadelphia, Pennsylvania, from September 6 to 11 inclusive. The following tentative program is subject to change and will be enlarged.

MONDAY, SEPTEMBER 6

9:30 A. M.—Council Meeting, Bellevue-Stratford Hotel.

2:00 P. M.—General Meeting, Bellevue-Stratford Ball Room.

Welcome by Mayor W. Freeland Kendrick.

Response by President James F. Norris.

Addresses by: Prince P. Ginori Conti—"The Development of Chemical Industry in Italy." Irénée du Pont—"The Dyestuff Industry, Forerunner of What?"

8:00 P. M.—Reception and entertainment, Sesqui-Centennial Auditorium.

TUESDAY, SEPTEMBER 7

9:30 A. M.—Divisional Meetings, University of Pennsylvania.

2:00 P. M.—Divisional Meetings, University of Pennsylvania.

8:00 P. M.—President's Address—James F. Norris, president of the American Chemical Society—"A Look Ahead."

Award of Priestley Medal to Edgar F. Smith.

Priestley Lecture. Edgar F. Smith—"Joseph Priestley."

WEDNESDAY, SEPTEMBER 8

9:30 A. M.—Divisional Meetings, University of Pennsylvania.

2:00 P. M.—General Meeting, Bellevue-Stratford Ball Room.

Addresses by: Irving Langmuir—"Flames of Atomic Hydrogen." (Illustrated.) Hugh S. Taylor—"Chemical Reactions of Atomic Hydrogen." (Illustrated.) Ernst Cohen—"Caricature in Science." (Illustrated.)

Presentation of Diplomas of Honorary Membership.

8:00 P. M.—Banquet—Bellevue-Stratford Ball Room—In honor of Founder Members, of whom S. A. Goldschmidt, J. B. F. Herreshoff, Adolph Kuttroff, Charles E. Munroe, Wm. H. Nichols and H. E. Niese are living, most of whom will be present.

THURSDAY, SEPTEMBER 9

9:30 A. M.—Divisional Meetings, University of Pennsylvania.

2:00 P. M.—Divisional Meetings, University of Pennsylvania.

8:00 P. M.—Group and Private Dinners.

FRIDAY, SEPTEMBER 10

9:30 A. M.—Divisional Meetings, University of Pennsylvania.

2:00 P. M.—Divisional Meetings, University of Pennsylvania.

SATURDAY, SEPTEMBER 11

Attend Sesqui-Centennial.

THE FIFTH PHILADELPHIA MEETING OF THE AMERICAN ASSOCIATION AND ASSOCIATED SOCIETIES

IT is possible at this time to make some statements regarding the preparations for the fifth Philadelphia meeting of the American Association and associated societies. The meeting will open on the evening of Monday, December 27, 1926, and will continue through the following Saturday.

The president for this meeting will be Dr. L. H. Bailey, the well-known leader in botanical and horticultural science. The retiring president, who will deliver an address at the opening session on the evening of December 27, will be Dr. Michael I. Pupin, of Columbia University, who presided at the Kansas City meeting last year. The chairman of the local committee which has charge of general arrangements for the meeting is Dr. C. E. McClung, of the University of Pennsylvania. The secretary of the committee is Dr. Samuel W. Fernberger, of the department of psychology of the University of Pennsylvania. Following is a list of the special subcommittees and their chairmen:

Finance, Mr. W. H. DuBarry
Meeting Places, Dr. G. H. Hallett
Hotels and Housing, Mr. G. E. Nitzsche
Publicity, Dr. Reese James
Exhibition, Dr. W. T. Taggart
Transportation, Mr. Thomas Hart
Entertainment, Mr. G. E. Nitzsche

Correspondence about local arrangements for the meetings of societies that are to meet with the association at Philadelphia should be addressed to the chairman of the local committee, Dr. C. E. McClung, Zoological Laboratory, University of Pennsylvania, Philadelphia, Pa.

The general headquarters hotel for the Philadelphia meeting will be the Bellevue-Stratford. A list of other hotels available for those who will attend the meeting, together with prices, etc., will appear in SCIENCE early in the fall.

Reduced railway rates on the usual certificate plan have been secured for most of the United States and it is probable that practically all the United States and Canada will be included in these rates. By this arrangement the railway fare for the trip to Philadelphia and return will be one and one half times the regular one-way fare.

Special emphasis will be placed this year on the public lectures and on the scientific exhibition. There will be a number of scientific lectures primarily for men of science, and also a number of lectures and demonstrations planned for the general public. A statement about the plans for the exhibition has appeared in SCIENCE for June 4, 1926. The meeting promises to be a very large one, with practically all lines of science well represented. Twenty-nine of the scientific societies have thus far intimated their plans for meeting with the association at Philadelphia. The scientific sessions will be held mainly in the halls of the University of Pennsylvania, which will be placed at the services of the association. The university and other Philadelphia institutions of learning are to be the hosts for this meeting.

Additional notices and announcements about the fifth Philadelphia meeting will appear from time to time in SCIENCE as plans mature. A rather full preliminary announcement of the meeting is to be published in the journal about December 1.

BURTON E. LIVINGSTON,
Permanent Secretary

SCIENTIFIC NOTES AND NEWS

THE University of Wisconsin, at its seventy-third commencement, conferred the doctorate of laws on President Max Mason, formerly professor of mathematical physics in the university, and the degree of doctor of science on Dr. Alfred North Whitehead, professor of mathematics at Harvard University; on Charles F. Burgess, electrochemist and president of the Burgess Laboratory, formerly professor in the university, and on Dr. William Snow Miller, professor emeritus of anatomy.

YALE UNIVERSITY conferred the degree of doctor of laws on President Max Mason and the degree of doc-

tor of science on Dr. Lee de Forest, the inventor, and on Dr. A. R. Dochez, associate professor of medicine at the college of physicians and surgeons of Columbia University.

PRINCETON UNIVERSITY has conferred the doctorate of science on Dr. William Holland Wilmer, director of the Wilmer Institute for Diseases of the Eye at the Johns Hopkins Hospital, and on Owen D. Young, chairman of the board of the General Electric Company.

THE degree of LL.D. has been conferred by the University of Rochester on Dr. Dexter S. Kimball, dean of the college of engineering of Cornell University.

DR. ALICE HAMILTON, associate professor of industrial medicine in the Harvard Medical School, received the degree of doctor of science at the commencement of Mount Holyoke College.

THE degree of doctor of science has been conferred by Wesleyan University on Dr. Henry Sewall, professor of physiology in the University of Denver.

DR. GILBERT GROSVENOR, president of the National Geographic Society, was the recipient of the degree of Litt.D. at the recent commencement of Amherst College. Nellie Barnes Foster, M.D., associate professor of medicine at Cornell University, received the degree of doctor of science.

AT the forthcoming Oxford meeting of the British Association, from August 4 to 11, Professor A. S. Eddington will deliver an evening discourse upon the subject of "Stars and Atoms," and Professor H. F. Osborn one on "Discoveries in the Gobi Desert by the American Museum Expedition."

DR. ROBERT A. MILLIKAN, director of the Norman Bridge Laboratory of the California Institute, has been elected a foreign member of the Göttingen Academy of Sciences.

DR. WILLIAM BOWIE, chief of the division of geodesy of the U. S. Coast and Geodetic Survey and president of the section of geodesy of the International Geodetic and Geophysical Union, has recently been elected to membership in the Norske Videnskapsakademie (Norwegian Academy of Sciences) in Oslo, Norway.

PROFESSOR G. H. HARDY, Savilian professor of geometry in the University of Oxford, has been elected a corresponding member of the Vienna Academy of Sciences.

A JOINT committee representing the Royal Society of Edinburgh, the Royal Physical Society and the Royal Scottish Geographical Society, has made the first award of the Bruce Memorial Prize to Mr. James Mann Wordie, of St. John's College, Cambridge, for his geological and oceanographical work in Arctic and Antarctic regions.

SIR DUGALD CLERK, K.B.E., well known for his work on the development of the internal combustion engine, has been elected prime warden of the Goldsmiths' Company.

AT the close of the current academic year, Dr. Richard Hawley Tucker will retire as astronomer in the Lick Observatory and professor of astronomy in the University of California. He has held this position for thirty-three years, of which three years, on leave of absence, were occupied with the construction and work of the San Luis Observatory of the Carnegie Institution. He will live for the immediate future at Palo Alto.

HAROLD K. PLANK, formerly associate entomologist in charge of the New Orleans field station of the U. S. Bureau of Entomology, has been appointed to the position of entomologist in the Tropical Plant Research Foundation. He will conduct investigations of the sugarcane moth-stalk borer, with field headquarters at Central Jaronú, Province of Camagüey, Cuba.

DR. W. E. LAWSON, of the E. I. du Pont de Nemours Company, should have been included in the list of Chemical Warfare Service consultants published in SCIENCE.

WALTER GUINNESS, minister of agriculture and fisheries for Great Britain, has appointed Mr. J. R. Jackson, deputy chief veterinary officer of the department, to be chief veterinary officer in place of Sir Stewart Stockman, who died on June 2.

PROFESSOR A. STOCK, of Dahlem, Berlin, has been appointed director of the chemical institute at the Technische Hochschule in Carlsruhe.

LEONOR MICHAELIS, professor at the University of Berlin and recently professor of biochemistry at the University of Nagoya, Japan, has been appointed resident lecturer in research medicine at the Johns Hopkins University and has begun his research work at the Johns Hopkins Hospital.

THE non-resident lecturer in chemistry at Cornell University for the first term of the next university year will be Dr. Fritz Paneth, professor of inorganic chemistry at the University of Berlin. He will present the results of his research and study concerning the "General Significance of Radiochemistry," "Isotopes," "The Periodic System from the Viewpoint of Bohr's Atomic Theory," "The Hydrogen Compounds of the Chemical Elements," "Natural and Artificial Trans-

formation of the Elements" and the "Use of the Radio-Elements as Indicators."

DR. R. J. TILLYARD, chief of the entomological department of the Cawthron Institute, of Nelson, New Zealand, is visiting the United States. Dr. Tillyard spoke recently before the Entomological Society of Washington, at a special meeting in his honor, on the subject of fossil insects; and at a luncheon given to him by some of the men in the Bureau of Entomology, he spoke on the problems of New Zealand in economic entomology.

THE London *Times* reports that Professor Hugh Cabot, professor of surgery in the University of Michigan, is visiting London, taking charge for a fortnight of the teaching of surgery in Sir Holburt Waring's clinic at St. Bartholomew's Hospital and Medical College. Professor Cabot was admitted to a meeting of the council as an honorary perpetual student of St. Bartholomew's Medical College, an honor conferred only once before, when Professor Harvey Cushing had charge of the teaching of surgery in Professor Gask's clinic at St. Bartholomew's in 1922.

PROFESSOR JOHANNES FIBIGER, of Copenhagen, in recognition of his services to cancer research, was entertained by the medical staff of the Cancer Hospital, London, to dinner on June 7. Among those present were Sir Humphry Rolleston, Sir John Bland-Sutton and Professor Muir, of Glasgow.

Nature states that at the anniversary meeting of the Linnean Society on May 27 the presentation to the society by Sir David Prain, on behalf of the subscribers, of a portrait of the general secretary, Dr. Benjamin Daydon Jackson. The portrait, by Mr. Ernest Moore, will commemorate Dr. Jackson's long and helpful association with the society as an officer for a period of forty-six years.

A PORTRAIT, painted by H. A. Nolan, of Dr. Rudolph Matas, professor of surgery in the Louisiana School of Medicine at New Orleans, was presented to the school by his students on June 8.

THE thirtieth anniversary of the first patent of wireless telegraphy was celebrated on June 13 in Bologna by a ceremony in honor of Senator Guglielmo Marconi. This was held at the university, in the presence of Signor Belluzzo, minister of finance; the syndic of Bologna, the representatives of many learned societies and the professors of the university. After a few words by the syndic, Senator Marconi made an address. He concluded by recalling his great teacher, Adolfo Righi, the Bolognese scientist, who made important studies of electric waves. After the ceremony a gold medal was presented to Senator Marconi. The rector also announced that a yearly prize for the best science student has been instituted under the name of Guglielmo Marconi.

THE Mayor of New York City, Mr. James J. Walker, has addressed a letter to Dr. William T. Hornaday on the occasion of his retirement in which he says: "Your retirement from the service of the City of New York must occasion regret to all thoughtful and appreciative citizens. By your own efforts, however, you have constructed a fitting monument to the intelligence, the efficiency and the fidelity which have characterized your service—I mean the finest zoological park in the world. It is seldom that the opportunity is given to a man to accomplish something that can at the same time captivate the heart of the child and awaken the world-wide admiration of the scientific world. This you have done by your patience, your skill and your devotion to duty. As Mayor of the city I thank and congratulate you on your splendid achievement."

THE permanent secretary of the American Association, Professor Burton E. Livingston, of the Johns Hopkins University, is to be at the Desert Laboratory, Tucson, Arizona, until the end of September. He will be engaged in further studies on the water relations of plants.

DR. ALEXIS CARREL and Dr. Pierre Lecomte du Noüy, of the Rockefeller Institute for Medical Research, sailed for France, on June 5.

Professor Paul S. Welch, of the Department of zoology, of the University of Michigan, has returned to America after a sojourn of about ten months in Europe where he visited universities, research institutes, museums and biological stations in England, Scotland, France, Belgium, Holland, Denmark, Germany, Switzerland and Italy.

DR. L. M. MASSEY, of the department of plant pathology of Cornell University, is spending six weeks in the Rocky Mountain Region of the United States investigating some of the problems of smelter injury.

DR. JACOB LIPMAN, of Rutgers University, recently visited Russia for the purpose of inviting a delegation of Russian agricultural experts to attend the International Society Conference on Soil Science, of which he is president, to be held in Washington in the summer of 1927. The American State Department is extending official invitations to representatives of all countries, including Russia, to attend this conference.

DR. PODKOPAYEV, senior physiologist of the Russian Academy of Sciences and director of the Pavlov Institute, is being sent to Sweden and England to lecture on the work of the Pavlov Institute of Leningrad

and on researches in the domain of cerebral physiology.

MME. CURIE is among a party of fifteen French scientists, who sailed on June 26 for Rio de Janeiro and São Paulo, in respose to an invitation to the French government extended through the Brazilian Embassy, the object being to give a series of lectures to afford students of Brazil an opportunity to gain first-hand knowledge of French science and art.

DR. DUNCAN S. JOHNSON, professor of botany and director of the laboratory and botanical garden of the Johns Hopkins University, sailed for Jamaica on July 2 to conduct researches on the development of the liverworts, the Myrtaceae, the water moulds and the banana, and on the taxonomy and ecology of lichens and ferns. Dr. Johnson is accompanied by Dr. William Maxon, Professor Charles C. Plitt, Professor J. N. Couch, A. F. Skutch, P. R. White, Mr. and Mrs. Paul Acquarone, M. S. Curtler and G. Duncan Johnson.

THE American Museum of Natural History's Greenland expedition, which will collect rare specimens of marine life, has sailed on the schooner *Effie M. Morrissey* for Etah, Greenland, led by George Palmer Putnam, publisher. Captain Robert A. Bartlett, owner and master of the schooner, was captain of the steamship *Roosevelt* on two of Admiral Peary's North Pole expeditions. Others aboard are the son of the discoverer of the North Pole, Robert E. Peary, Knud Rasmussen, the Danish explorer, who is acting as general adviser; H. E. Raven, zoologist; Ezra Winter, artist; Peter Heinbecker, surgeon; Fren Linekiller, taxidermist, and Van Campen Heilner, ichthyologist.

A GROUP of collectors from the Field Museum, Chicago, sailed from New York on June 19 for Rio de Janeiro, whence they will proceed inland into South America in search of specimens of mineral, animal and plant life. Marshall Field, 3rd, financed the undertaking and Mrs. Grace Thompson Seton is a member of the expedition. The expedition plans to reach Rio de Janeiro on July 1, going directly to the Organ Mountains. The subsequent route includes a visit to São Paulo and into the unknown Parana River region past the Iguazu Falls. Mrs. Seton is official historian and photographer of the party. Other members of the expedition are George K. Cherrie, who accompanied Theodore Roosevelt on his trip along the River of Doubt; B. E. Dahlgren, J. R. Miller and George Peterson, botanical staff; H. W. Nichols, geological expert, and K. P. Schmidt and C. C. Sanborn, specialists in animal collections.

A PROPOSAL for a memorial to Alexander Graham Bell, inventor of the telephone while a professor at Boston University, in the form of a chair of the science and art of speech at the College of Liberal Arts at Boston University, was presented to a group of fifty prominent Bostonians at a recent dinner in Boston. General John J. Carty, vice-president of the American Telephone and Telegraph Company, was the principal speaker. Senator William M. Butler sent a telegram regretting his inability to be present and pledging $5,000 for the fund. Ernest G. Howes, a member of the board of trustees, pledged $5,000, and $35,000 was pledged by Everett W. Lord, dean of the College of Business Administration, on behalf of the alumni and student body of his department.

THE New York Academy of Sciences has decided to raise a research fund of at least $6,000 to commemorate the services of Dr. Ralph Winfred Tower, librarian from 1904 to 1926, and secretary from 1917 to 1926, who died on January 26, after a brief illness.

A MEMORIAL was unveiled at Lebanon, Conn., on June 29, to Dr. William Beaumont, the pioneer American physiologist and distinguished member of the U. S. Army Medical Corps. Dr. Beaumont was born in Lebanon, on November 21, 1785.

DR. JOHN HOWLAND, professor of pediatrics in the Johns Hopkins Medical School and pediatrician-in-chief of the Johns Hopkins Hospital, died in London on June 20, after an internal operation performed following a collapse. Dr. Howland was fifty-three years old.

DR. HENRY M. WHELPLEY, dean of the St. Louis College of Pharmacy, secretary of the United States Pharmacopoeial Convention and former president of the American Pharmaceutical Association, died on June 26, at the age of sixty-five years.

DR. C. B. CARTER, research chemist in the Mellon Institute of the University of Pittsburgh, known for his work in leather chemistry, was killed in an accident on the Pennsylvania Railroad, on June 16. He received the doctorate of philosophy from the University of North Carolina on June 16.

LIEUTENANT-GENERAL SIR WILLIAM LEISHMAN, K.C.B., F.R.S., director-general of the British Army Medical Service, died on June 2, aged sixty years.

SIR FREDERICK WALKER MOTT, the distinguished British neurologist, died on June 6 at the age of seventy-two years.

THE death is announced of Professor Nils Gustaf von Lagerheim, professor of botany and director of the Botanical Institute of the University of Stockholm.

A CORRESPONDENT writes: The Consultative Eugenics Committee of Norway has lost one of its most

prominent members by the death of Chr. Collin. Shortly before he died he wrote down his views on the eugenic work to be done, giving support to the Norwegian Eugenic Program, worked out at the Winderen Laboratorium, Oslo.

CHI CHAPTER of Phi Lambda Upsilon, national honorary chemical fraternity, was installed at the State College of Washington on June 5 by J. R. Lorah, of Epsilon Chapter, University of Washington. The new chapter has ten charter members and seven elected members.

ON June 1, one hundred of the leading manufacturers and representatives of the industrial interests of Indiana assembled at Purdue University for the purpose of discussing the relationship of research to the industrial interests of the state. The conference was held at the personal invitation of Mr. David E. Ross, a member of the board of trustees of the university.

THE International Association for Psychology and Techno-Psychology was organized on March 15. Fifteen European countries are represented in the association, the administrative headquarters of which are at Riga, under the direction of Dr. Moeller. In England the association is represented by Professor T. H. Pear, of the University of Manchester, and Dr. C. S. Myers, of the National Institute of Industrial Psychology. The first publication of the association will be "A Survey of the Organization and Position of Techno-Psychology."

THE annual congress of the English South-Eastern Union of Scientific Societies opened on June 5 at Colchester, under the presidency of Mr. Reginald A. Smith, of the British and Medieval Antiquities Department of the British Museum. The union consists of antiquarian, architectural, botanical, geological and natural science societies and photographic, field and rambling clubs. Over seventy societies were represented at the congress. A number of excursions to local places of scientific interest were arranged. The presidential address of the various sections were delivered by Mr. Robert Paulson (botanical section), Mr. E. C. Stuart Baker (zoölogical section), Mr. S. H. Warren (geological section) and Mr. Alexander Farquharson (regional survey section).

THE Daniel Guggenheim Fund for the Promotion of Aeronautics proposes prizes amounting to between $150,000 and $200,000 for inventions increasing the safety of airplanes.

THE Presbyterian Hospital of New York City, affiliated with Columbia University, has received a bequest of the greater part of the residuary estate of Louis Sherry, restaurateur, said to amount to a million dollars. The fund is to be known as the Bertha Sherry Memorial Fund and is to be used for the benefit of cancer patients.

ACCORDING to the Italian correspondent of the *Journal* of the American Medical Association a Society of Experimental Biology was recently founded at Pavia, with Senator Giulio Fano, professor of physiology at the University of Rome, as president. All Italian devotees of experimental biologic subjects are eligible to membership. The purpose of the society is to promote research in biology. Its headquarters will be in the city where its president resides. In localities in which at least ten members reside subchapters will be created. The organ of the new society is the *Bollettino della società di biologia sperimentale,* the president of the society being ex-officio the managing editor. The bulletin will publish the proceedings of the regional and the plenary meetings, and the summaries of the scientific communications, the general reviews and the discussions pertaining thereto.

LEHIGH UNIVERSITY has established two new research fellowships in engineering, founded by an endowment fund created by Mrs. Henry M. Byllesby, widow of the late president of the Byllesby Engineering and Management Corporation, who received his degree in mechanical engineering from Lehigh. Although the subjects to be investigated under the fellowships may be proposed by the president of the Byllesby Corporation, the funds are to be administered and the work directed by the institute of research of Lehigh University. In common with all other activities of the institute, the work will follow lines of pure research and the results will be immediately available to the engineering profession. The two Henry Marison Byllesby Memorial Research Fellowships will be awarded for a period of two academic years, with an annual stipend of $750 and freedom from university fees.

UNIVERSITY AND EDUCATIONAL NOTES

GIFTS and legacies for the past year reported at the recent commencement of Harvard University amounted to $6,925,457. This amount does not include receipts in the $10,000,000 campaign, payment of subscriptions to the Harvard (alumni) endowment fund and certain other income and legacies. The largest single legacy received was $2,242,616 from the estate of Artemas Ward, which came to the university unrestricted. Next was the bequest of $700,000 from the estate of Joseph R. DeLamar for the medical school.

In addition to the customary gifts to the Yale Alumni Fund and to gifts made during the year for buildings as already announced, the university has received by gift and bequest several new endowment funds totaling about $475,000 since the report made by the president to the alumni at commencement a year ago.

Frank A. Hitchcock, physicist of the U. S. Bureau of Standards, has been appointed professor of civil engineering at George Washington University.

Dr. Arthur G. Bills, of the University of Chicago, and Dr. William T. Heron, of the University of Kansas, have been appointed assistant professors of psychology in the University of Minnesota.

Dr. Freeman Ward, state geologist of South Dakota and professor of geology at the university, has been appointed head of the department of zoology at Lafayette College, to succeed the late Professor Peck.

Dr. A. L. Melander, for twenty-two years entomologist at the State College of Washington and head of the department of zoology, has been appointed professor of biology and chairman of the biological faculty at the College of the City of New York.

Dr. William T. Richards, son of Dr. Theodore W. Richards, of Harvard University, after two years spent abroad (at Cambridge, London, Copenhagen, Paris and Göttingen) as fellow in science of the International Education Board, has been appointed instructor in chemistry at Princeton University.

Professor A. J. Clark, of University College, London, will succeed the late Professor A. R. Cushny in the chair of materia medica at the University of Edinburgh.

DISCUSSION

THE TERM PSYCHOZOIC

Facetious undergraduates have more than once suggested that the familiar geologic succession of the Cenozoic, of Eocene, Oligocene, Miocene, Pliocene and Pleistocene might be fittingly concluded by the term Obscene for the Recent—an idea doubtless suggested by either the modern novel or the modern psychology.

The problem of just how we shall round out the upper end of the geologic time table is much like the similar problem of how we shall start it at its beginning—one not easily decided satisfactorily. To be sure, we live in the present, at least some of us hope that we do, and the past is behind us—I have even heard it said of some that their future was also behind them.

It is probably good philosophy to commence earth history with a hypothetical Archeozoic era, but is it equally good philosophy to terminate earth history with a Psychozoic era? No one would probably gainsay the magnitude and multiferous effects of human activity, but these are scarcely of geologic magnitude, and I can conceive of many past events as being of much greater importance than the advent of man, if viewed with a certain degree of detachment. Such, for example, as the origin of life itself, or the transfer of the main theater of organic operations—both animal and plant—from the water to the land. It might be conceivable that the first mammal or the first flowering plant (Angiosperm) was more of an event than the first man. Man becomes impressive as one of a gang, and the necessity for these weakest of mammals, among their contemporaries of the Old Stone age, to hunt in packs, was doubtless the inception of that nationalistic impulse of which we see such a strong recrudescence at the present time.

It seems to me that a Psychozoic era is not only a false assumption, but altogether wrong in principle, and is really nurtured as a surviving or atavistic idea from the holocentric philosophy of the Middle Ages—typified by our contemporary ancestors of the south.

There can be no objection to speaking of the present as the Age of Man—or Woman, for that matter—but this is a quite different thing from setting up Psychozoic as a formal era. For this the term possesses no qualifications, either with respect to the time involved, the sediments deposited or the distinctness of a lower boundary—either stratigraphic, faunal or floral.

E. W. Berry

Johns Hopkins University

THE WEST FORK OF THE GILA RIVER

Mention is made of Mr. T. T. Swift's contribution in reference to Mr. Kirk Bryan's article "Date of Channel Trenching (Arroyo cutting) in the Arid Southwest." [1] Like Mr. Swift, the writer's knowledge of the Gila River region has extended over a period of twenty-five years, of which nineteen have been spent in the Forest Service, but this experience has been confined to the upper reaches of that stream near its sources. In all probability, the first white man to invade the fastness of the upper Gila was James Pattie with a party of Kentuckians on a beaver-trapping expedition in the midwinter of 1825. Fortunately, Pattie left an intensely interesting account of his wanderings in the southwestern wilderness of one hundred years ago. Pattie's "Personal Narrative" throws some illuminating light on conditions in the vicinity of the Gila River and its adjacent terrain, before the white man brought his so-called civilization into the region. Pattie and his party first encountered what is now known as the West Fork of

[1] Science, October 16, 1925.

the Gila, in December, 1825. He says: "The next morning accompanied by another man I began to ascend the bank of the stream to explore . . . the first day we were fatigued by the difficulty of getting through the high grass which covered the heavily timbered bottom." If Pattie could only see it now!

This same West Fork of the Gila, where Pattie first set foot, is now, within a brief one hundred years, a boulder-strewn stream, where countless cattle have lived and wandered and died since the white man first brought his herds of domestic cattle, in the early eighties. There is now scarcely a vestige of grass for miles, in what Pattie described as the "heavily timbered bottom" and even the cottonwoods and willows have been eaten off or trampled under foot by the constantly moving cattle. The innumerable canyons and arroyos which are tributary to the west Fork of the Gila are deeply scoured by flood waters due to the grazing off of the adjacent hillsides.

Twenty-five years ago, when the writer first saw the West Fork, conditions were worse, if anything, than they are now. The irreparable damage was done when cattle were first crowded on to the range between the years 1885 and 1895. Nat Straw, an old-time prospector and trapper, informed the writer that on his first visit to the region in 1876 (a period of only fifty-one years after Pattie), trout could easily be taken where now there is a sluggish and unshaded stream, filled from bank to bank with flood waters during the summer rainy seasons. The pity of it is that the West Fork of the Gila River is still within an unsettled and undeveloped region. The damage has been done, not by extensive cultivation or by stock owned by many settlers or farmers but for the most part by individual owners of large herds. The Forest Service has long been attempting to better conditions by reducing the size of the herds and by better distribution, but the damage has been done and the remedy, if effective, will never bring the West Fork back to its pristine glory.

FRED WINN

TUCSON, ARIZONA

SIZE INHERITANCE

THE inheritance of quantitative characters, particularly of plants, has been explained frequently on the basis of independently inherited, cumulative factors, each of equal weight in determining size. In this hypothesis it is usually further assumed that each factor has one half the effect in the heterozygous condition that it has in the homozygous condition.

Such a hypothesis may be tested directly by determining the correlation between the size character of the F_2 and the F_3 generations. Irrespective of the number of independent, cumulative factors involved in the inheritance of a particular quantitative character, the correlation coefficient between the F_2 and the F_3 generations for that character will be approximately $+0.816 \pm E_r$. This is based on the assumption that the F_2 individuals tested in F_3 truly represent a random sample of all possible combinations in F_2 and further that each F_2 tested is represented in F_3 by the same number of individuals. The number of individuals necessary in F_3 will, of course, depend on the number of factors involved.

R. J. GARBER

WEST VIRGINIA UNIVERSITY

FUNDAMENTALISM IN NORTH CAROLINA

ON May 4 a semi-political organization of fundamentalists called "The Committee of One Hundred" (one hundred counties in the state) met in Charlotte and passed a lengthy resolution from which the following paragraphs are taken:

> We are unalterably opposed to the union of church and state.
>
> Inasmuch as our state supported schools are not permitted to teach the Bible we are strongly opposed to their teaching any doctrine which tends to destroy the faith of our people in the scriptures as the authoritative word of God. We want to emphasize the fact that we are not seeking to cripple any of our state schools but to strengthen them and thereby inspire our people with confidence in said institutions as safe places for our boys and girls.
>
> We hold that it is not sufficient for a teacher to justifiy himself in his disbelief that the Bible is the word of God upon the ground that he does not teach this in his class, inasmuch as education is by life as well as by lip and by example as well as by precept.
>
> This organization has nothing to do with either denominational schools or those that are privately owned, inasmuch as they are supported by voluntary contributions.
>
> We do not question the right of freedom of thought or research. "We believe in freedom by the truth," and in freedom to search for the truth, but we challenge the right of those in charge of our state schools to employ teachers who hold views fundamentally contrary to the simple teaching of the Bible and force the taxpayer to pay the bills.
>
> The duties of the directors will be to endeavor by conference with proper authorities and by treaty to correct the abuses complained of. In case of failure to accomplish the desired results by conference and treaty it is incumbent upon us to avail ourselves of our constitutional rights and apply to the legislature for redress of our grievances.

The boards of trustees and the administrations of the three state institutions, the University of North Carolina, the North Carolina College for Women and the North Carolina State College, now face a mod-

ern Protestant holy inquisition. It is of course unthinkable that these bodies will in any degree whatsoever meet the desires of the fundamentalists so that the latter will be forced to carry their fight into the legislature of next winter.

Well financed, the Committee of One Hundred has imported fifteen speakers under the direction of Mr. T. T. Martin, head of the Bible Crusaders of America, who will, in addition to local talent, prepare the counties for the June primaries where the next legislature is made. There seems to be little doubt that this theological raid on education in North Carolina will assume much more serious proportions than it did a year and a half ago when an anti-evolution bill met defeat. The Rev. Mr. Martin states that North Carolina is "pivotal" and that if it can be won the nation can be also.

An interesting corollary is a possible paradoxical situation created by the fact that the Baptist and Methodist institutions, Wake Forest and Duke, respectively, are standing firm for freedom of teaching. Thus in case the fundamentalists swamped the state institutions, it would become desirable, to prevent the "ruin of youth," to transfer the young men in the church schools to the "safe" state fundamentalist colleges.

B. W. WELLS

NORTH CAROLINA STATE COLLEGE

QUOTATION

LEADERS IN MEDICINE

THE science of medicine has suffered heavy loss by the deaths within the last few days of Sir William Leishman and Sir Frederick Mott. Both were pioneers in the truest sense of that word; in both a lively imagination was disciplined by unswerving fidelity to the truth; to both it was given to render signal service to their generation and to posterity. Leishman was a soldier, and it is not straining the use of language to say that he carried the ideals of his profession into his scientific studies. His work—with Wright—on the prevention of typhoid fever, thanks to which that immemorial scourge of armies was practically eliminated during the Great War, was in its essence a discipline of the natural powers of resistance to disease imposed before inevitable exposure to infection took place. The discipline of the parade-ground aims at a similar if a larger object. The patience and courage necessary to this work on typhoid fever were of the highest order. They were displayed again and again in Leishman's life, and never more conspicuously than in his studies of Kala-azar. This soldier, indeed, took no discharge in the war against disease.

In that respect his service closely resembled Mott's. The distinguished pathologist of the London County Asylums died, literally, at his post, at a moment when he was pursuing in old age the aims which had fired his youthful enthusiasm. The guiding principle of Mott's life was the determination to discover, if possible, the real causes of insanity. He believed that "mental disease" possesses, in many instances at least, a physical basis, and he worked successfully to justify that faith. His labors, as is now evident, opened a new epoch in the study of lunacy. There are visible to-day powerful stirrings of the old stagnant waters of asylum life. Indeed the very word asylum has been abolished in favor of the more hopeful term "mental hospital." "Hotel-keeping and oratory," as the duties of medical superintendents of those institutions were once cynically defined, have give place to a new interest in research and a new determination to afford to the mentally afflicted all the benefits which are enjoyed by those who are sick in body. This enterprise is still in its earliest phase, but the course of its evolution is no longer in doubt. The debt which humanity owes to Mott is certain, therefore, to increase immeasurably as time goes on. He was a maker of modern medicine, an architect of that healthier and happier future in which he so passionately believed.—London *Times*.

SCIENTIFIC BOOKS

Life and Evolution; an Introduction to General Biology. By S. J. HOLMES. iv + 449 pp., 227 figs. New York, Harcourt, Brace and Co. 1926.

HOLMES has added another to the considerable list of introductory text-books of general biology written by American professors in the last decade. It shows the same tendency that most of them do, to treat the subject more as a physiological and philosophical one than did similar treatises of twenty years ago, with scant attention to morphology and classification, which formed the backbone of biology prior to 1900. The tendency coincides with the direction of growth of the subject and it is natural that this should be emphasized in an up-to-date text-book. But a pedagogic question suggests itself as to whether the older aspects of the subject are not being too much neglected in our elementary biological teaching. Is there such a thing as a biogenetic law governing the acquisition of a knowledge of biology? Should the pupil progress in the order of the developmental stages of the subject? The professors who write the text-books have themselves been well grounded in anatomy, morphology and classification. Will their pupils attain the desired point of view without climbing up this ladder, or may the beginner be taken by the coat collar and

landed at once on the top rung? However this may be, Holmes can not be accused of making false pretenses. He entitles his book "Life and Evolution" and discusses the elementary facts of organic life to such an extent only as seems indispensable to a clear understanding of evolution. His material is well selected, presented in an interesting way, and his reasoning is well balanced and judicial. The newer aspects of zoology, such as experimental embryology and genetics, are adequately reviewed. Organic evolution, on which subject the author has written much and ably, is treated with especial fulness and clarity. As the title of the book indicates, this is its objective, a worthy and timely one in view of the renewed popular interest in the subject. Holmes's moderate and judicial treatment of it is much better calculated to promote clear thinking and sound conclusions than some ill-tempered and denunciatory writings that are enjoying wide popularity at present.

There is this to be said in favor of the newer type of general biology course as outlined in Holmes's book. Biology is presented as a subject with lively human interest and eminently practical in its bearings on everyday life. The reproach that used to attach to the bug-man or the flower-man in the public eye, as an impracticable chaser and classifier of useless things, does not attach to the newer biology. A book such as Holmes has produced can be read with interest and profit by the intelligent layman no less than by the college student.

Evolution, Genetics and Eugenics. By H. H. NEWMAN. 2nd Edit., xx + 639 pp., 99 figs. Univ. of Chicago Press. 1925.

NEWMAN has attempted a useful but difficult task, to cull the best things from all the standard books on evolution and genetics and to bring these together in a single volume for the use of his pupils. The idea appeals to every teacher as just what he would like to do for his class, and this perhaps accounts in part for the obvious success of Newman's book, now in its second edition. But when one comes to the execution of this ideal plan of text-book making, he encounters serious difficulties. What Darwin, Wiesmann, Conklin or Thompson wrote about a subject was in its original setting a masterly statement, but removed from that setting, clipped to fit into the limits of a paragraph, and put together with clippings from other writers into a single chapter, it may lose much of its value. The whole now lacks unity, orderliness and logical sequence. What was meant for a symposium of the masters has become a hash of disconnected opinions, one of which, so far as the reader can see, is as good as another. A scientific scrapbook does not make a good text-book.

It is also in questionable taste to devote a chapter in a science text-book to the Scopes trial and related matters more or less mixed up with religion and politics. What has a dignified text-book to do with propaganda? It is the business of science to discover truth, and of a science teacher to inculcate methods of discovering truth. But it is not the business of a scientist to cram any one's opinions down the throat of the public. Let the fundamentalists and modernists have their fight out in the churches and courtrooms, if they will, but let us keep the halls of science clean.

Heredity. By A. F. SHULL. xi + 287 pp., 111 figs. New York, McGraw-Hill Book Co. 1926.

THIS book differs from all other text-books on the subject in that it is designed primarily for those with no previous knowledge of biology. Incidentally one who reads it attentively will acquire a considerable knowledge of several phases of biology. The author finds an interest in heredity wide-spread among college students outside as well as inside of the biological department. He believes the same to be true outside the colleges, and has undertaken with marked success to tell the public what heredity is, how it acts and what practical application it has, particularly in human society. The book is scientifically sound, well written and illustrated, and admirably adapted to fill its purpose, that of giving authoritative information to the public about heredity and eugenics.

Experiments in Genetics. By C. C. HURST. xxiv + 578 pp., 175 figs. Cambridge (Eng.) University Press. 1925.

THIS volume includes the more important papers of the author on the genetics of plants, animals and man, published in various journals in the thirty-year period, 1894–1924, here brought together and republished from Trinity College, Cambridge. The first four papers deal with experiments in the hybridization of orchids, inspired by reading Darwin's "Fertilization of Orchids," and carried out in the pre-Mendelian era. The author was fortunate in being closely associated with Bateson subsequent to 1900 and had a large share in the wonderfully fruitful work of the group of Mendelians headed by Bateson. Hurst's investigations cover a wide range of subjects. His studies of the hybridization of orchids acquired new significance and were interpreted in new ways after the rediscovery of Mendel's law. He also repeated and verified some of Mendel's experiments with gar-

den peas; made experiments showing Mendelian inheritance of coat-characters in rabbits (Angora coat, albinism, gray coat, Dutch markings); and made experimental crosses between four breeds of poultry, involving a large number of character differences in plumage, comb and other morphological characters. He established an experimental farm at Burbage, where he was on more than one occasion host to visiting scientists from British Association meetings or international congresses. Here he conducted breeding experiments with horses, showing among other things that chestnut color is a Mendelian recessive to bay. He also demonstrated Mendelian inheritance in the fruit colors of tomatoes, red, yellow or white.

At Burbage Hurst made a valuable study of eye-color in man, making a personal examination of the eye color of entire families, parents and children, and thus securing data of unrivalled accuracy and value. He established for the first time the true nature of blue eyes, a Mendelian recessive character, in which the iris lacks pigment on its anterior wall. Other human studies made by Hurst relate to hair color, skin color, left-handedness, musical ability, etc. He made extensive studies of egg-production in poultry crosses, but these, like the horse-breeding experiments, were largely terminated by the war. His principal post-war studies relate to the genus rosa, in which he regards polyploidy, species hybridization and apomixis as important agencies in the production and spread of new specific or subspecific forms.

Truly Hurst's work forms a remarkable record of varied and productive activity, in a period in which genetics came into existence, a genesis which Hurst personally saw and of which he was a part. Long may his fruitful labors continue.

W. E. Castle

Bussey Institution

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE MEASUREMENT OF SURFACE TENSION BY MEANS OF A CHAINOMATIC BALANCE

During investigations on the penetration of killing agents into weeds, it became necessary to determine the surface tension of the fluids used. No apparatus was available for these tests, so use was made of a Chainomatic balance as a modification of the standard ring method of determining surface tension. Counterbalanced wires were hung from the lower pan hooks on the beam ends of the balance, the left-hand wire terminating in a small platinum wire bent into a circular loop of known size, at right angles to the line of pull. The scale pans were left on the balance and an old dissecting microscope stand was used to carry the vessel of liquid to be tested. The foot of this microscope was milled out so as not to touch the oscillating scale pans and an arm and tray were soldered to the rack and pinion to hold a vessel of the liquid to be tested.

In using this device the balance beam is lowered and the vessel of the liquid raised by the rack and pinion of the dissecting microscope so that the surface of the liquid comes in contact with the wire loop hanging from the balance. Care must be used in keeping the wire loop clean. By adjustment of the rack and pinion, equilibrium is established with the pointer needle at zero. The sliding scale of the "Chainomat" is then lowered slowly until the film holding the loop breaks. The reading of the scale indicates the weight necessary to break the surface film. From this and the known size of the wire loop the dynes tension may be calculated.

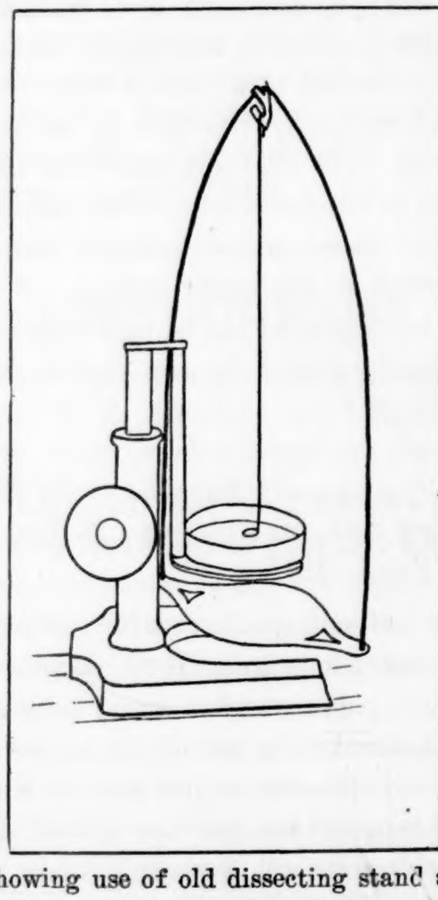

Diagram showing use of old dissecting stand and Chainomatic balance in measuring surface tension.

This instrument has been used quite successfully to date in making surface tension readings. Its cheapness and ready convertibility, coupled with the fact that quite small quantities of liquid may be tested, recommend its use where other methods are not available.

L. W. Durrell
Fred G. Person
Charles F. Rogers

Agricultural Experiment Station,
Fort Collins, Colorado

SPECIAL ARTICLES

ON THE ELIMINATION OF HEAT FROM NORMAL AND PATHOLOGIC SUBJECTS AS DETERMINED FROM CALORIMETRIC STUDIES OF THE EXTREMITIES

SOME years ago Stewart[1] made a study of the circulation in man, dealing almost entirely with blood flow in the hands and feet of both normal and pathologic subjects. In his writings he states that "the quantity of blood in grammes flowing through the hand in the time of the experiment is given by

$$Q = \frac{H}{T - T_1} \cdot \frac{1}{S}$$

in which Q is the quantity of blood, H the heat given off by the blood, T the temperature of the venous blood and S the specific heat of the blood."

I do not believe that the Stewart equation nor any similar equation can be applied correctly to the determination of blood flow. Calorimetric data *per se* can be used only for the determination of heat elimination. And, in turn, the elimination of heat from an extremity is dependent not only on the rate or quantity of blood flow, but also upon various conditions of the blood vessels and radiation factors, namely: (1) Dilated or constricted capillaries or peripheral blood vessels, (2) the number of capillaries functioning, which microscopic studies show varies considerably in different individuals[2] and (3) the capillary blood flow.

The well-known equation for heat conduction is

$$Q = K\,(T_1 - T_2)\frac{A}{D}\,t$$

in which Q is the quantity of heat in calories conducted from the extremity to the calorimetric bath in a given time t; K is the conductivity constant; T_1 and T_2 are, respectively, the temperatures of the two bodies; A is the area over which the conduction of heat from one medium to another takes place; D is the thickness and vascularity of the conducting layer.

It is also well known that the heat taken up by the calorimeter can be found from the equation

$$H = (m + m_w)\ (T_3 - T_2)$$

in which H is the heat in calories developed in the calorimeter of water equivalent m_w containing a mass of water m, while $T_3 - T_2$ represents the rise in temperature during the time t.

The temperature of the arterial blood in the extremities varies slightly in different cases. Stewart considered 36.7° C. as being a sufficiently exact value. I have taken 37° C. as being, in general, satisfactory since the conclusions reached are not modified by assumptions of a slightly higher or lower amount.

The increase of temperature of M grams of water (*m* grams of water and m_w the water equivalent) is

$$\frac{Q}{M} = \frac{H}{m + m_w} = K_1 \frac{\Delta T}{M} \cdot t$$

in which $\Delta T = 37° - T$, T° Centigrade being the temperature of the calorimeter and contents at any given time t; or

$$\frac{Q}{M} = K_2\ (37° - T)t$$

in which $K_2 = K_1/M$

The rate of increase of the temperature of the immersion bath—which also represents the rate of elimination of heat from the extremity—is given as

$$\frac{dT}{dt} = K_2\,(37° - T)$$

From this equation, by integration, we finally obtain

$$-\log_{10}\,(37 - T) = K_3 t + C$$

If T_1 represents the temperature gradient $(37° - T)$ of the extremity (ΔT_1) at time t_1 and T_2 the corresponding value of the temperature gradient (ΔT_2) at time t_2, then

$$K_3 = \frac{1}{t_1 - t_2} \log_{10} \frac{T_2}{T_1}$$

This equation is the fundamental one involved in calorimetric studies of the extremities, and from the determination of K_3, the rate of transfer of heat from an extremity immersed in a water bath, it is possible to establish certain conclusions of physiological and medical importance.

Applications of the foregoing equation to the data obtained by Stewart demonstrate quite conclusively that there is no evidence of the marked increases in blood flow with time of immersion in the calorimeter which Stewart believed to be present in both normal and pathologic subjects. There is, furthermore, no evidence of any change in the rate of blood flow in any given subject under the conditions of experimentation laid down, provided there is included in the definition of the term "blood flow" the various factors which may affect it or which are the equivalent of such flow.

The conclusions drawn from these studies are:

(1) Calorimetric methods and data can not be used to determine the quantity or rate of blood flow.

(2) Only quantities of heat (Q) and rates (K_3) of transfer of heat can be determined in such calori-

[1] Stewart, "Harvey Lectures," pp. 80–149, 1912–13; "Heart," pp. 33–88, 1911–12.

[2] Sheard, SCIENCE, LX, p. 409, 1924; Brown, "*American Annals of Clinical Medicine,*" I, p. 69, 1922; Brown and Giffin, *American Journal of Medical Sciences,* V, 166, p. 459, 1923; Sheard and Brown, *Journal Laboratory and Clinical Medicine,* X, p. 925, 1925; and Krogh, "Anatomy and Physiology of the Capillaries," Yale Press, 1922.

metric investigations, in which a temperature gradient exists between the immersed extremity and the calorimetric bath.

(3) The equation of conduction of heat

$$Q = K(T_1 - T_2)A/D \cdot t$$

is applicable to calorimetric studies of the extremities.

(4) The rate of increase (K_3) of the temperature of the calorimeter and contents due to the peripheral or surface circulation is given by the expression

$$K_3 = \frac{1}{t_1 - t_2} \cdot \log_{10} T_2/T_1$$

(5) Analyses of the experimental results made by the use of this equation, in which $\log_{10} \Delta T$ is plotted as ordinate relative to the time, t, as abscissa, show that there are two distinct portions: (1) that given by the transfer or elimination of heat by virtue of the temperature gradient existing between the foot and the calorimetric bath due to the inherent heat capacity or *tissue heat* of the extremity plus the effects due to surface circulation and (2) that given by the transfer or elimination of heat due solely to *circulatory conditions at or near the surface.*

(6) From a study of normal persons under various conditions of environmental temperature and under the régime of experimentation which has been adopted, there is evidence that (1) the rate of transfer or elimination of heat due to the surface or peripheral circulation *per se* is very approximately directly proportional to the temperature, in degrees Centigrade, of the surrounding environment; (2) the inherent thermal capacity of the superficial or surface layers of the extremity increases proportionately to the square of the temperature in degrees Centigrade of the surrounding atmosphere or environment, and (3) when the temperature of the surrounding environment reaches approximately 15° C. the rate of transfer of heat from the exposed surface of a resting human body becomes negligibly small, as is indicated by the value of the rate of elimination of heat due to the existing conditions of surface circulation.

(7) A comparison of data on the inherent thermal capacities of extremities in normal subjects, in cases of polycythemia and of thrombo-angiitis obliterans (Buerger's disease) shows that there is but little difference in general between that in normal subjects, and that in cases of polycythemia, but that there is a marked difference between the values in Buerger's disease and those obtained in normal subjects.

(8) A study of the rates of elimination of heat at the surface of an extremity due to conditions of surface circulation indicates that this rate of heat elimination may be from two to five times as great in cases of polycythemia as in the normal subjects under similar environmental temperature and, again, about half as great in cases of thrombo-angiitis obliterans (Buerger's disease) as in normal subjects.

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CHROMOSOME VIII IN MAIZE

THE *Pr pr* factor pair, which modifies aleurone color in maize from red to purple, has long been known and has been used extensively in linkage studies. All the published data as well as my own unpublished results indicate that this factor pair does not belong to any of the seven linkage groups in maize which have already been reported. At least five factor pairs, of which four are new and have not previously been described, have been found by the writer to be linked with the *Pr pr* factor pair. A brief description of each of these factor pairs as they are expressed in the soma follows:

(1) *Bm bm,* a factor pair, which, when homozygous recessive, causes a water-soluble, yellowish-brown pigment to develop in the cells of the midrib and sheath of the leaves. This character comes into expression when the plant is about six weeks old and persists throughout the remainder of the life of the plant. This linkage relation was first observed in the summer of 1923. Backcross data from plants grown in 1925 substantiated this linkage and showed a crossing over value between *Pr* and *Bm* of 20 per cent.

(2) Sc_1 sc_1, a factor pair for scarred endosperm, as described in the University of Missouri Agricultural Experiment Station Research Bulletin 52.

(3) Fi_2 fi_2, a factor pair for a fine striping of the chlorophyll, which appears in young seedlings and persists through the life of the plant. The character expression varies from a pure albino, on the one hand, to a nearly green plant, on the other, with plant vigor roughly proportional to the amount of chlorophyll bearing tissue.

(4) *Yg yg,* a factor pair, which, when homozygous recessive, causes the seedling as well as the growing plant to be distinctly yellowish-green in color, due to a deficiency in the chloroplastid pigments. As these plants approach maturity, it becomes increasingly difficult to distinguish them from normal green plants.

(5) *Tn tn,* a factor pair, which, when homozygous recessive, produces a small slender plant with a usually very small ear shoot, a small unbranched tassel, and leaves which are always strongly tinged with anthocyanin.

This group of linked factors is especially interesting in that it represents a new chromosome in maize, to be designated as chromosome VIII.

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